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ABSTRACT

Twenty-three self-contained single concept physics demonstration packages were designed and constructed at Lamar University (Texas). Each package was available for loan to pre-college science instructors in southeastern Texas in the spring and summer of 1987. During the spring, three high school physics teachers used the demonstrations and provided evaluations that resulted in minor modifications in them. In the fall, five schools participated. Follow-up visits to the teachers who used the demonstrations revealed that some teachers needed both extensive help with the experiments and a broader conceptual base. The project continues by Lamar University with the addition of demonstrations to the lending library and increased school participation. A primary project focus is the establishment of communication with pre-college teachers in need of help but reluctant to seek it. A sheet for each of the demonstration packages provides a statement of the concepts illustrated, a description of the package, and suggested activites. (MSE)

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A LENDING LIBRARY OF PHYSICS DEMONSTRATIONS

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Principal Investigator

HE023201

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

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AASCU/ERIC Model Programs Inventory Project

The AASCU/ERIC Model Programs Inventory is a two-year project seeking to establish and test a model system for collecting and disseminating information on model programs at AASCU-member institutions--375 of the public four-year colleges and universities in the United States.

The four objectives of the project are:

- To increase the information on model programs available to all institutions through the ERIC system
- To encourage the use of the ERIC system by AASCU institutions
- To improve AASCU's ability to know about, and share information on, activities at member institutions, and
- To test a model for collaboration with ERIC that other national organizations might adopt.

The AASCU/ERIC Model Programs Inventory Project is funded with a grant from the Fund for the Improvement of Postsecondary Education to the American Association of State Colleges and Universities, in collaboration with the ERIC Clearinghouse on Higher Education at The George Washington University.

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Technical Description of Project and Results

In accordance with the proposed goals of this project, twenty three physics demonstration packages have been designed, constructed and assembled into a "lending library". This library is housed and maintained in the physics building at Lamar University. Each package is complete in every detail and ready to use with no additional equipment needed. A list of the demonstrations available, a description of each demonstration package, and a copy of the letter sent to the pre-college physics teachers and some selected physical science teachers in the South-east Texas area follows.

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT

NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I—PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Lamar University P.O. Box 10046 L.U. Sta. Beaumont, TX. 77710	Materials Development	MDR-8550611
	4. Award Period From 2/1/86 To 4/30/88	5. Cumulative Award Amount $13,866.

6. Project Title

A "Lending Library" of Physics Demonstrations

PART II—SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

During the period of the grant, the principal investigator designed and constructed twenty three self-contained, single concept physics demonstration packages. Each package was available to be checked out by pre-college science teachers in Southeast Texas. Workshops on the use of the demonstrations were provided in the Spring and Summer of 1987.

During the Spring of 1987, the demonstrations were used by three high school physics teachers with whom the principal investigator is well acquainted. These teachers provided evaluations of the program which led to minor modifications.

During the Fall 1987 semester, five schools participated. Packages were delivered by either the principal investigator or a student assistant and then picked up in one week.

The principal investigator made follow up visits to all participating teachers. As a result of these visits, he discovered some teachers who needed intensive help not only with the demonstration packages, but a broader base of concepts.

The project will be continued by Lamar University. Demonstrations will be added to the library. Participation will be increased. A main focus of the project will be the establishment of communication with pre-college teachers in need of help, but reluctant to seek it.

PART III—TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (✓)	Approx. Date
a. Abstracts of Theses	X				
b. Publication Citations	X				
c. Data on Scientific Collaborators	X				
d. Information on Inventions	X				
e. Technical Description of Project and Results		X			
f. Other *(specify)* Dissemination of Results		X			

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
Joseph F. Pizzo, Jr.		5/5/88

NSF Form 98A (1-87) Supersedes All Previous Editions

Form Approved OMB No. 3145-0058

LAMAR UNIVERSITY
The State-Supported University in Southeast Texas

August 27, 1987

Dear Physics Educator,

This is an invitation to make use of the Lamar University "Lending Library of Physics Demonstrations". I have enclosed a list of the demonstrations available, along with a packet which includes a brief description of each demonstration.

If you see anything that you can use in your physics or physical science classes, please call and have a demonstration package sent out to you. Each package is complete down to the last detail - you do not have to worry about searching for any auxiliary equipment. There is absolutely no charge for this service. It is made possible through a grant from the National Science Foundation. The demonstration packages will be delivered and picked up each Friday afternoon starting September 4. There is no charge for this service either. If this is not a convenient time for you to receive the demonstrations, you can make arrangements to pick them up at the Lamar University Physics Building at your convenience.

Each demonstration package may be kept for one week (we suggest you try out most of the demonstrations yourself before you use them in class). We will not limit the number of packages (within reason) that may be checked out at one time unless the demand becomes too great.

I have already made duplicate copies of some packages, for which I anticipate heavy demand, and will continue to do so as conditions dictate. If you want to illustrate a concept for which I have no demonstration, let me know. I want to add to the holdings of the "Library".

As you use these demonstrations, you may discover that many are so simple that you could duplicate them yourself and start your own collection. I hope so! Let me know if I can ever help you locate anything you need.

Department of Physics
P. O. Box 10046 Beaumont, Texas 77710 409 880-8241

Finally, feel free to call on me for advice or suggestions at anytime. I look forward to working with you in the interest of Physics Education in our Community.

Your colleague,

Joe

Joe Pizzo
Professor of Physics

Usage

The preceding letter, package list, and demonstration descriptions were sent to twenty two pre-college teachers, on August 27, 1987. Five teachers chose to participate during the Fall, 1987 semester. It is the opinion of the principal investigator that participation can and will be increased by follow up letters and personal contact.

A list of participating schools and package distribution follows on the next page. The location of the schools and their approximate distance from Lamar is given below.

School	City	Dist. from Lamar
Stephen F.Austin High School (SFA)	Port Arthur	10 miles
Westbrook High School	Beaumont	10 miles
Port Neches-Groves High School (PNG)	Port Neches	15 miles
High Island High School	High Island	40 miles
Lumberton Intermediate School	Lumberton	20 miles

DEMONSTRATION PACKAGES

	9/11-9/18	9/18-9/25	9/25-10/2
Ambient Noise Resonators			
Analysis of Sound			
Artificial Sunset			
Bed of Nails			
Center of Mass	SFA *		
Curved Space			
Diffraction			
Gumby Ride			SFA
Interference			
Low Temperature Effects			
Mudslinger 1		Westbrook	
Mudslinger 2		PNG	
Newtonian Gravity		Westbrook	
Non-Inertial Ref. Frame			
Polarization: Scattering			
Polarized Light			
Rotating Platform			SFA
Scattering			
Singing Sewer Pipes			
Spectra			
Standing Waves on a Rope			
Tablecloth "Trick" 1		Westbrook	
Tablecloth "Trick" 2		PNG *	
Vibrating Membrane			

Weight in Newtons SFA PNG

DEMONSTRATION PACKAGES

	10/2-10/9	10/9-10/16	10/16-10/23
Ambient Noise Resonators			
Analysis of Sound			
Artificial Sunset			
Bed of Nails		PNG	
Center of Mass		PNG	
Curved Space			
Diffraction			
Gumby Ride		PNG	
Interference			
Low Temperature Effects			
Mudslinger 1			
Mudslinger 2			
Newtonian Gravity		SFA	
Non-Inertial Ref. Frame			SFA *
Polarization: Scattering			
Polarized Light			
Rotating Platform			
Scattering			
Singing Sewer Pipes			
Spectra			
Standing Waves on a Rope			
Tablecloth "Trick" 1			
Tablecloth "Trick" 2			
Vibrating Membrane			

DEMONSTRATION PACKAGES

	10/23-10/30	10/30-11/6	11/6-11/13
Ambient Noise Resonators			
Analysis of Sound			
Artificial Sunset			
Bed of Nails		High Island	
Center of Mass			
Curved Space	PNG *		
Diffraction			
Gumby Ride			Wrstbrnk
Interference			
Low Temperature Effects			
Mudslinger 1			
Mudslinger 2			
Newtonian Gravity	PNG		HighIsland
Non-Inertial Ref. Frame	PNG		High Island
Polarization: Scattering			
Polarized Light			
Rotating Platform	PNG		
Scattering			
Singing Sewer Pipes			
Spectra			
Standing Waves on a Rope			
Tablecloth "Trick" 1			
Tablecloth "Trick" 2			
Vibrating Membrane			

Weight in Newtons HighIsland

DEMONSTRATION PACKAGES

	11/13-11/20	11/20-11/25	11/25-12/4
Ambient Noise Resonators			
Analysis of Sound			
Artificial Sunset		High Island	
Bed of Nails			
Center of Mass			
Curved Space			Westbrook*
Diffraction			
Gumby Ride			
Interference			
Low Temperature Effects			
Mudslinger 1			
Mudslinger 2			
Newtonian Gravity		High Island	
Non-Inertial Ref. Frame			
Polarization: Scattering			
Polarized Light		High Island	
Rotating Platform			
Scattering			
Singing Sewer Pipes			
Spectra			
Standing Waves on a Rope			
Tablecloth "Trick" 1			
Tablecloth "Trick" 2			
Vibrating Membrane			

* make visit myself

DEMONSTRATION PACKAGES

	12/4-12/11	1/4/88
Ambient Noise Resonators		
Analysis of Sound		
Artificial Sunset	Lumberton*	
Bed of Nails		
Center of Mass		
Curved Space		
Diffraction		
Gumby Ride		
Interference		
Low Temperature Effects		
Mudslinger 1		
Mudslinger 2		
Newtonian Gravity		
Non-Inertial Ref. Frame		
Polarization: Scattering		
Polarized Light		
Rotating Platform		
Scattering		
Singing Sewer Pipes		
Spectra		
Standing Waves on a Rope		
Tablecloth "Trick" 1		
Tablecloth "Trick" 2		
Vibrating Membrane		

Significance of the Project

While the number of participants was small, it is felt that the results are significant and the project is one that could be emulated by many colleges and universities.

The original goal of the project was to supply pre-college teachers with ready to use physics demonstrations to enhance the traditional delivery of science education by lecture and laboratory. That purpose is certainly served. In fact two experienced educators who have used the packages have copied many of the demonstrations and are now building their own library.

However, the main significance of the project is one that was not fully anticipated. Three pre-college teachers of physics have used the demonstration packages as an "excuse" to open a dialogue with the principal investigator and reveal their lack of preparation in physics. (The best background among the three is two semesters of algebra based physics.) Why the Boards of Education should allow such situations to exist is not of immediate concern to the principal investigator. The main objective at this time is to offer every possible assistance in addition to the demonstration packages. The principal investigator has even been asked by two teachers to take over one of their classes while they observed.

The significant point is that without the demonstration packages as a focus, it would not have been easy for these teachers to identify themselves and take the principal investigator into their confidence. While either delivering the packages himself or making follow up visits, the college teacher has the opportunity to interact with the pre-college teacher in a way that is neither intimidating nor patronizing.

It is the opinion of this investigator that the availability of pre packaged demonstrations offers an excellent opportunity to open lines of communication with the pre-college teachers in the area.

Dissemination of Results

In order to share the results of this project with as many educators as possible, the principal investigator has made several presentations to science teachers at both the national and regional levels:

1. " Demonstrations to Go ", a workshop presented to the Science Teacher Association of Texas regional conference, in Beaumont, Texas, April 25, 1987.

2. " A Lending Library of Physics Demonstrations - A Pilot Project ", a presentation to the American Association of Physics Teachers national meeting in Bozeman Montana, June 17, 1987.

3. " A Lending Library of Physics Demonstrations ", a presentation to the Conference on the Advancement of Science Teaching in San Antonio, Texas, November 21, 1987.

4. " Demos to Go ", an invited paper to be presented to the national meeting of the American Association of Physics Teachers in Ithica, New York, June, 1988.

5. The principal investigator has been invited by the Region XIII Education Service Center to present a workshop for the Austin area Physics teachers. Date of presentation will be June 30, 1988.

Future Directions

The physics department at Lamar University will continue the support of the project by supplying equipment, student assistance and transportation.

The principal investigator plans to extend the project in the following ways:

1. After using the demonstrations from Lamar's library, teachers will be offered encouragement and assistance in constructing their own library of demonstrations.

2. Ideas for new demonstrations will be solicited from pre-college teachers and added to the Lamar library.

3. Demonstrations will be cross referenced by topic.

4. Video tapes will be made, showing the principal investigator setting up and using each demonstration package. Upon request, a copy of the tape will be available with the demonstration package.

5. The principal investigator will continue to use the "carrot" of the demonstration packages to seek out and work with those teachers whose physics background is inadequate.

AMBIENT NOISE RESONATOR

CONCEPTS ILLUSTRATED

1. STANDING WAVES
2. SPEED OF SOUND IN AIR
3. FREQUENCY SPECTRUM OF NOISE

DESCRIPTION OF PACKAGE

1. EIGHT 1 1/2 INCH PVC PIPES OF DIFFERENT LENGTH
2. ONE PADDLE

SUGGESTED ACTIVITIES

1. PLACE YOUR EAR CLOSE TO EACH PIPE AND LISTEN TO THE TONE. EACH ONE REINFORCES A NOTE OF THE SCALE TWO OCTAVES BELOW "MIDDLE C".
2. STRIKE THE PIPES WITH THE PADDLE. TRY TO PLAY A "SONG".

ANALYSIS OF SOUND

CONCEPTS ILLUSTRATED

1. SOUND WAVES
2. HARMONIC COMBINATION

DESCRIPTION OF PACKAGE

1. FOURIER SYNTHESIZER
2. OSCILLOSCOPE
3. MICROPHONE
4. WIRES
5. SPEAKER

SUGGESTED ACTIVITIES

1. USE FOURIER SYNTHESIZER TO SHOW FIRST, SECOND, AND THIRD HARMONICS ON THE OSCILLOSCOPE. LISTEN TO THEM. SHOW HOW FREQUENCY IS INDICATED ON THE OSCILLOSCOPE.
2. SHOW COMBINATION OF HARMONICS ON THE OSCILLOSCOPE. POINT OUT THAT THE COMBINATIONS ALL HAVE THE FREQUENCY OF THE FUNDAMENTAL. LISTEN TO THE DIFFERENT QUALITY OF EACH COMBINATION.
3. LET THE STUDENTS USE THE MICROPHONE TO SEE THE HARMONIC COMBINATIONS FROM THE VOICE. (VOWEL SOUNDS SUCH AS $\bar{O}$ AND $\bar{E}$ CAN HAVE A RELATIVELY SIMPLE HARMONIC CONTENT)
4. HAVE THE STUDENTS BRING MUSICAL INSTRUMENTS TO SCHOOL IN ORDER TO ANALYZE THE SOUND.

ARTIFICIAL SUNSET

CONCEPTS ILLUSTRATED

1. SCATTERING
2. WHITE LIGHT COMPOSED OF RED, GREEN, AND BLUE
3. FREQUENCY DEPENDENCE OF SCATTERING

DESCRIPTION OF PACKAGE

1. PLASTIC TANK WITH FLAT SIDES
2. "SUN SLIDE"
3. ONE BOTTLE OF 1 NORMAL HCL
4. ONE BOTTLE OF SODIUM THIOSULFATE SOLUTION
5. ONE GRADUATED CYLINDER
6. TWO BEAKERS
7. SLIDE PROJECTOR

SUGGESTED ACTIVITIES

1. SHOW THAT AS SCATTERING INCREASES, A BEAM OF WHITE LIGHT WILL LOSE BLUE AND GREEN, RESULTING IN THE TRANSMISSION OF RED
2. COMPARE THIS TO A SETTING SUN

BED OF NAILS

CONCEPTS ILLUSTRATED

1. PRESSURE IS INVERSELY RELATED TO THE AREA OVER WHICH A FORCE IS APPLIED

DESCRIPTION OF PACKAGE

1. BED OF NAILS SUFFICIENT FOR COVERAGE BY THE AVERAGE BACK OR BUTT
2. SAFETY LID
3. "PRESSURE TESTER"
4. CALIBRATED WEIGHTS
5. SCALES
6. PLATFORM FOR SCALES

SUGGESTED ACTIVITIES

1. LIE ACROSS OR SIT ON THE BED OF NAILS TO SHOW THAT THE PRESSURE IS NOT SUFFICIENT TO CAUSE PAIN
2. USE THE "PRESSURE TESTER" TO FIND THE AMOUNT OF PRESSURE THAT IS UNCOMFORTABLE
3. MAKE SOME SEMI-QUANTITATIVE ESTIMATES OF PRESSURE EXPERIENCED ON THE BED OF NAILS (IN UNITS OF NEWTONS PER NAIL)

CENTER OF MASS

CONCEPTS ILLUSTRATED

1. BALANCED TORQUES
2. CENTER OF MASS

DESCRIPTION OF PACKAGE

1. "CUT OUT" OF THE STATE OF TEXAS
2. SUPPORT FROM WHICH TO SUSPEND "CUT OUT"
3. PLUMB-BOB
4. SCALE (READING IN NEWTONS)
5. PLANK (2 M LONG BY 15 CM WIDE)
6. PLATFORMS TO SUPPORT EACH END OF PLANK

SUGGESTED ACTIVITIES

1. SUSPEND THE STATE OF TEXAS BY TWO POINTS (ONE AT A TIME) AND DETERMINE THE GEOGRAPHICAL CENTER OF TEXAS.
2. PLACE A STUDENT ON THE PLANK, SUPPORTED AT HEAD AND FOOT. READ THE FORCE HOLDING UP ONE END. USE METHOD OF BALANCED TORQUES TO FIND THE CENTER OF MASS OF THE STUDENT.

CURVED SPACE

CONCEPTS ILLUSTRATED

1. EINSTEIN'S MODEL OF GRAVITY
2. SCATTERING BY AN ATTRACTIVE POTENTIAL

A.) RELATION BETWEEN IMPACT PARAMETER AND ORBIT

B.) RELATION BETWEEN KINETIC ENERGY AND ORBIT

DESCRIPTION OF PACKAGE

1. A SECTION (0.3M HEIGHT) OF A LARGE DIAMETER CYLINDRICAL TUBE (SONOTUBE)
2. ONE PIECE OF 2-WAY STRETCH FABRIC
3. ONE LARGE ELASTIC BAND
4. ONE SHOT-PUT
5. TWO SMALL BALLS

SUGGESTED ACTIVITY

1. USE ELASTIC TO HOLD STRETCH FABRIC TIGHTLY OVER TUBE
2. ROLL BALL ACROSS THE FLAT SPACE AND WATCH IT FOLLOW A STRAIGHT LINE
3. PLACE SHOT-PUT IN CENTER OF FABRIC
4. ROLL BALL ACROSS "CURVED SPACE" AND WATCH IT FOLLOW A CURVED TRAJECTORY
5. CHANGE THE IMPACT PARAMETER AND INITIAL SPEED TO SEE THE EFFECT ON THE ORBIT

DIFFRACTION

CONCEPTS ILLUSTRATED

1. DIFFRACTION
2. COLOR

DESCRIPTION OF PACKAGE

1. SMALL BRIGHT LIGHT IN A LARGE FRAME
2. TRANSFORMER
3. SEVERAL OBJECTS WITH SMALL APERTURES

SUGGESTED ACTIVITIES

1. LET STUDENTS VIEW THE BRIGHT LIGHT THROUGH THE DIFFERENT OBJECTS
2. HAVE STUDENTS FIND AND BRING OBJECTS FROM HOME THAT WILL DIFFRACT LIGHT

GUMBY RIDE

CONCEPTS ILLUSTRATED

1. FRICTION
2. CENTRIPETAL FORCE

DESCRIPTION OF PACKAGE

1. DRILL
2. VARIAC
3. CIRCULAR CAGE
4. FINGER CLAMPS AND SUPPORTS
5. GUMBY

SUGGESTED ACTIVITIES

1. MOUNT CAGE ON DRILL AND SLOWLY INCREASE SPEED WITH VARIAC. PLACE GUMBY ON THE SIDE OF THE CAGE (FEET OFF THE FLOOR) WHEN SPEED IS SUFFICIENT
2. REDUCE SPEED AND WATCH GUMBY FALL
3. REPEAT STEP 1 AND THEN INVERT THE CAGE
4. REPEAT STEP 2

INTERFERENCE - LIGHT

CONCEPTS ILLUSTRATED

1. INTERFERENCE
2. COLOR

DESCRIPTION OF PACKAGE

1. SODIUM VAPOR LAMP
2. TWO PIECES OF PLATE GLASS
3. LASER
4. DOUBLE SLIT SETS
5. BUBBLE SOLUTION AND BLOWER

SUGGESTED ACTIVITIES

1. PUT ONE PIECE OF PLATE GLASS ON TOP OF THE OTHER AND ILLUMINATE WITH SODIUM VAPOR LAMP. LOOK FOR INTERFERENCE PATTERNS FORMED BY LIGHT REFLECTING FROM TOP AND BOTTOM OF AIR GAP.
2. ILLUMINATE ONE DOUBLE SLIT SET WITH THE LASER AND EXAMINE THE INTERFERENCE PATTERN ON A DISTANT SCREEN. COMPARE TO THE PATTERN FORMED BY THE OTHER SLITS WITH A DIFFERENT SEPARATION.
3. LOOK AT THE COLORS ON A SOAP BUBBLE. THEY ARE FORMED WHEN DIFFERENT FREQUENCIES OF LIGHT COMBINE CONSTRUCTIVELY AT DIFFERENT THICKNESS OF THE SOAP FILM.

MUDSLINGER

CONCEPTS ILLUSTRATED

1. INERTIA

DESCRIPTION OF PACKAGE

1. ONE DOWEL
2. ONE PIECE OF SILLY PUTTY

SUGGESTED ACTIVITIES

1. STICK THE SILLY PUTTY ON THE END OF THE DOWEL. WHIP THAT END OF THE DOWEL TO A HIGH VELOCITY. STOP THE DOWEL ABRUPTLY AND WATCH THE SILLY PUTTY MAINTAIN ITS STATE OF MOTION.

NEWTONIAN GRAVITY

CONCEPTS ILLUSTRATED

1. NEWTON'S CONCEPT OF GRAVITY AS A FORCE
2. CENTRIPETAL FORCE
3. INERTIA

DESCRIPTION OF PACKAGE

1. CIRCULAR PIECE OF PLATE GLASS
2. TWO AIR PUCKS
3. SUCTION CUP
4. BALLOON BLOWER

SUGGESTED ACTIVITIES

1. GIVE AIR PUCK A PUSH AND WATCH IT GO IN A STRIGHT LINE ACROSS THE PLATE GLASS
2. GIVE THE OTHER AIR PUCK (ATTACHED TO THE STRING ON THE SUCTION CUP) A PUSH AND WATCH IT GO IN A CIRCLE
3. USE THE ANALOGY OF THE SUCTION CUP AS THE SUN AND THE AIR PUCK AS THE EARTH TO SHOW NEWTON'S IDEA OF GRAVITY AS A "TUG"
4. NOTE THE IDEA OF INERTIA HERE: THE AIR PUCK WILL CONTINUE TO MOVE IN THE SAME DIRECTION UNLESS ACTED ON BY A FORCE

NON-INERTIAL REFERENCE FRAME

CONCEPTS ILLUSTRATED

1. LAW OF INERTIA
2. CENTRIFUGAL FORCE IS A FICTITIOUS FORCE

DESCRIPTION OF PACKAGE

1. ROTATING PLATFORM WITH PLATE GLASS TOP
2. MINIATURE GUMBY TO RIDE ON THE PLATFORM
3. AIR PUCK

SUGGESTED ACTIVITIES

1. ROTATE THE PLATFORM WITH GUMBY ATTACHED TO IT. WHEN GUMBY IS DIAMETRICALLY OPPOSITE YOU, PUSH AIR PUCK TOWARD HIM.
2. ASK THE CLASS TO DESCRIBE WHAT HAPPENS FROM GUMBY'S POINT OF VIEW.
3. REPEAT STEP #1, BUT HAVE A STUDENT STANDING ON THE FLOOR, DIAMETRICALLY OPPOSITE YOU, CATCH THE AIR PUCK. ASK STUDENTS TO DESCRIBE WHAT HAPPENS FROM HIS OR HER POINT OF VIEW.

POLARIZED LIGHT

CONCEPTS ILLUSTRATED

1. POLARIZATION BY SELECTIVE ABSORPTION
2. OPTICAL ACTIVITY
3. THREE-DIMENSIONAL VIEWING FROM A FLAT SURFACE
4. COLOR

DESCRIPTION OF PACKAGE

1. LARGE POLAROID OVERLAY FOR LOWER STAGE OF OVERHEAD PROJECTOR
2. SMALL POLAROID IN FRAME FOR TOP OF OVERHEAD PROJECTOR
3. 3-D POLAROID GLASSES
4. POLAROID SUN GLASSES
5. CELLOPHANE
6. PLEXIGLASS "STRESS TESTER"

SUGGESTED ACTIVITIES

1. DEMONSTRATE POLARIZATION BY SELECTIVE ABSORPTION BY USING CROSSED POLARIZERS ON OVERHEAD PROJECTOR
2. SHOW DIRECTIONS OF POLARIZATION OF LENSES OF 3-D GLASSES
3. SHOW DIRECTION OF POLARIZATION OF POLAROID SUN GLASSES
4. USE CELLOPHANE AND PLEXIGLASS WITH CROSSED POLARIZERS TO DEMONSTRATE THE ROTATION OF THE PLANE OF POLARIZATION BY OPTICALLY ACTIVE MATERIALS

POLARIZATION - SCATTERING

CONCEPTS ILLUSTRATED

1. SCATTERING
2. POLARIZATION

DESCRIPTION OF PACKAGE

1. LASER
2. WATER TANK
3. POWDERED CREAMER
4. PIECE OF POLAROID

SUGGESTED ACTIVITIES

1. SHOW HOW ADDING A SMALL AMOUNT OF POWDER INCREASES THE SCATTERING
2. VIEW THE SCATTERED LIGHT THROUGH A PIECE OF POLAROID. ROTATE THE POLAROID.
3. LOOK AT POLARIZATION OF LIGHT SCATTERED AT RIGHT ANGLES OPPOSED TO LIGHT SCATTERED AT OTHER ANGLES.
4. LET STUDENTS GO OUTSIDE AND VIEW THE SKY THROUGH THE POLAROID.

ROTATING PLATFORM

CONCEPTS ILLUSTRATED

1. CONSERVATION OF ROTATIONAL (ANGULAR) MOMENTUM
2. VECTOR NATURE OF ROTATIONAL MOMENTUM
3. ROTATIONAL INERTIA

DESCRIPTION OF PACKAGE

1. ROTATING PLATFORM
2. BICYCLE WHEEL WITH HANDLE
3. WEIGHTS

SUGGESTED ACTIVITIES

1. STAND ON THE ROTATING PLATFORM, SPINNING WITH ARMS OUTSTRETCHED. BRING YOUR ARMS DOWN TO YOUR SIDE
2. ACCEPT BICYCLE WHEEL (HANDLE VERTICAL) WHILE STANDING ON THE PLATFORM. ROTATE HANDLE 180 DEGREES
3. HAVE SOMEONE TRY TO TURN THE PLATFORM WHILE YOU STAND ON IT, HOLDING WEIGHTS DOWN AT YOUR SIDES; NOW TRY IT WITH ARMS OUTSTRETCHED (STILL HOLDING THE WEIGHTS)

SCATTERING

CONCEPTS ILLUSTRATED

1. SCATTERING
2. COLOR

DESCRIPTION OF PACKAGE

1. SLIDE PROJECTOR
2. "BEAM SLIDE"
3. AQUARIUM
4. POWDERED COFFEE CREAMER
5. WHITE CARDBOARD

SUGGESTED ACTIVITIES

1. OBSERVE BEAM FROM THE SIDE WITHOUT AND WITH SCATTERING PARTICLES IN THE WATER. (NOTE THE COLOR OF THE SCATTERED LIGHT.)
2. OBSERVE THE TRANSMITTED BEAM BY HOLDING A PIECE OF WHITE CARDBOARD IN FRONT OF IT. WHY IS IT YELLOW?

SINGING SEWER PIPES

(HOT AIR RESONATORS)

CONCEPTS ILLUSTRATED

1. SOUND
2. STANDING WAVES
3. BEATS

DESCRIPTION OF PACKAGE

1. THREE PVC PIPES (10 CM DIAMETER) OF LENGTHS: 113 CM, 120 CM, 150 CM
2. TWO MEKER BURNERS
3. GAS HOSES
4. T-CONNECTOR
5. PROPANE BOTTLE ADAPTED TO FIT GAS HOSE
6. INSULATED GLOVES

SUGGESTED ACTIVITIES

1. SLOWLY LOWER EACH PIPE OVER A BURNER UNTIL THE FLAME IS ABOUT 5 CM INTO THE PIPE. LISTEN TO THE TONES PRODUCED. RELATE FREQUENCY TO LENGTH OF PIPE.
2. USING TWO BURNERS, SOUND THE 113 CM PIPE AND THE 120 CM PIPE SIMULTANEOUSLY. THEIR FREQUENCIES ARE CLOSE ENOUGH TOGETHER TO PRODUCE BEATS.

SPECTRA

CONCEPTS ILLUSTRATED

1. COLOR
2. EMISSION LINES
3. DIFFRACTION

DESCRIPTION OF PACKAGE

1. HG "YARD LIGHT" (IN HOUSE)
2. NA "YARD LIGHT" (IN HOUSE)
3. LOW PRESSURE NA LAMP (IN HOUSE)
4. TUNGSTEN FILAMENT BULB (IN HOUSE)
5. THIRTY CARDBOARD MOUNTED DIFFRACTION GRATINGS
6. ONE "HIGHER QUALITY" DIFFRACTION GRATING
7. BICYCLE FENDER SPECTROMETER
8. MULTI-COLORED OBJECTS

SUGGESTED ACTIVITIES

1. EXAMINE THE COLORED OBJECTS UNDER EACH TYPE OF ILLUMINATION.

2. LOOK AT EACH SOURCE THROUGH A DIFFRACTION GRATING.

3. USE THE SPECTROMETER TO MEASURE THE WAVELENGTH OF SOME OF THE BRIGHTEST LINES IN THE VAPOR SOURCE.

STANDING WAVES ON ROPE

CONCEPTS ILLUSTRATED

1. TRANSVERSE WAVES
2. STANDING WAVES

DESCRIPTION OF PACKAGE

1. SABRE SAW
2. STAND AND CLAMPS FOR SABRE SAW
3. WEIGHTS FOR TENSION
4. VARIAC
5. STROBE LIGHT

SUGGESTED ACTIVITIES

1. SET UP A STANDING WAVE ON THE ROPE BY DRIVING THE SABRE SAW AT AN APPROPRIATE FREQUENCY
2. INVESTIGATE THE STANDING WAVE UNDER THE STROBE LIGHT IN ORDER TO SEE THE ACTUAL DISPLACEMENT OF EACH PART OF THE JUMP ROPE AS A FUNCTION OF TIME
3. USE THE VARIAC TO CHANGE THE FREQUENCY, THUS SHOWING THAT ONLY CERTAIN FREQUENCIES WILL RESULT IN A STANDING WAVE
4. VARY THE TENSION IN THE ROPE

TABLECLOTH TRICK

CONCEPTS ILLUSTRATED

1. INERTIA (MAYBE)
2. FRICTION (STATIC AND SLIDING)
3. ACCELERATION PROPORTIONAL TO FORCE
4. FINAL VELOCITY DEPENDS ON TIME OF ACCELERATION

DESCRIPTION OF PACKAGE

1. ONE TABLECLOTH (FLOWERED)
2. ONE DINNER PLATE
3. ONE CUP AND SAUCER
4. ONE GLASS

SUGGESTED ACTIVITIES

1. PULL THE TABLECLOTH OUT FROM UNDER THE SETTING WITHOUT DISTURBING THE DISHES

VIBRATING MEMBRANE

CONCEPTS ILLUSTRATED

1. STANDING WAVES IN TWO DIMENSIONS

DESCRIPTION OF PACKAGE

1. SPEAKER ENCLOSED IN A CANNISTER
2. THIN RUBBER MEMBRANE OVER CANNISTER
3. VARIABLE FREQUENCY SINE WAVE GENERATOR
4. AMPLIFIER
5. STROBE LIGHT

SUGGESTED ACTIVITIES

1. USE AMPLIFIED SINE WAVE THROUGH SPEAKER TO DRIVE THE RUBBER MEMBRANE IN FORCED OSCILLATIONS.
2. VARY THE FREQUENCY UNTIL THE MEMBRANE ACHIEVES A LARGE RESPONSE. AT THIS POINT, A STANDING WAVE HAS BEEN SET UP.
3. INVESTIGATE THE BEHAVIOR OF ALL PARTS OF THE MEMBRANE UNDER A STROBE LIGHT. TRY TO IDENTIFY NODAL LINES. IN SOME MODES THEY WILL BE CIRCLES; IN OTHER MODES THEY WILL BE STRAIGHT LINES.
4. FIND AS MANY DIFFERENT STANDING WAVE MODES AS YOU CAN.

WEIGHT IN NEWTONS

CONCEPTS ILLUSTRATED

1. S.I. UNIT OF FORCE
2. WEIGHT IS A FORCE

DESCRIPTION OF PACKAGE

1. BATHROOM SCALE READING IN NEWTONS
2. A 1N WEIGHT
3. A 10N WEIGHT
4. A BOX FILLED WITH WEIGHTS

SUGGESTED ACTIVITIES

1. ASK WHAT A POUND IS
2. PASS AROUND THE 1N AND 10N WEIGHTS
3. ASK EACH STUDENT TO ESTIMATE THEIR WEIGHT IN NEWTONS
4. USE SCALES TO MEASURE WEIGHT IN NEWTONS
5. HAVE STUDENTS LIFT THE BOX OF WEIGHTS
   A.) ASK SOME STUDENT FOR ESTIMATE IN POUNDS
   B.) ASK OTHER STUDENTS FOR ESTIMATE IN NEWTONS
   C.) CHECK THE ANSWERS

NOTE: THESE SCALES ARE NOT ACCURATE FOR SMALL WEIGHTS (LESS THAN 100N)